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JOINT THEATER MISSILE DEFENSE INTEROPERABILITY

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature:

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Bayard W. Russell, Captain, US Navy

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Underpinning the issue of TMD resource allocation and employment are the issues of interoperability and integration of Joint Force, i.e., service component unique, Battle Management/Command, Control and Communications (BM/C3) systems into an information architecture that supports TMD. The problem of TMD BM/C3 interoperability is aggravated in coalition or multi-national warfare, where all TMD players do not have equal access to information.

BM/C3 Tactical Data Processors (TDPs) have embedded data correlation or data fusion algorithms as the "brain" of the system used to develop a common picture of the battlespace. These data correlation algorithms may take the form of mathematical equations, "IF - THEN" statements or logical rules. The differences between data correlation algorithms is reflected as differences in the common picture displayed in a BM/C3 system among the various TMD players and the JFC.

In order to improve multi-service and multi-national interoperability in the near term, the JFC commander may selectively alter the information architecture within a specific theater to optimize data correlation and better develop a single, common picture of the battlespace. In the long term, the JFC must advocate the joint acquisition of BM/C3 systems that not only "look alike," but "think alike."

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Abstract of

JOINT THEATER MISSILE DEFENSE INTEROPERABILITY

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Chapter 1:
INTRODUCTION

The use of Theater Ballistic Missiles (TBMs) in regional warfare is not a new phenomenon (circa Desert Storm). Quite the contrary, the use of TBMs dates back to 13 June 1944 when Nazi Germany attacked Swanscombe, England with a V-1 rocket. Nazi Germany developed the second generation TBM, the V-2, and launched nearly 3,100 missiles at England and Western Europe between 8 September 1944 and 27 March 1945. Theater Missile Defense (TMD) against the V-1, a subsonic missile, was attempted during World War II with limited success. The defensive measures used against the V-1 involved what is now termed Active Defense (AD), which included bomber sorties against V-1 missile launch sites and interdiction of missiles in flight by anti-aircraft guns or fighter aircraft.[1] The introduction of the V-2, a supersonic missile, negated all previously developed strategies for countering the TMD threat.

With the end of World War II, the advent of the nuclear age and the start of the Cold War, TBMs matured into Intercontinental Ballistic Missiles (ICBMs). These weapons appeared to be the exclusive domain of the two super powers and the defensive measure developed to counter the threat was one of Mutually Assured Destruction (MAD) which led to deterrence. This MAD policy was able to succeed, in part, due to the development of computer technology that allowed for rapid, automated data correlation; enhanced, early detection of launch events (development of better ground-based radar) and fast, accurate prediction of ICBM impact locations. Concurrent with the development of computer technology was the development of satellite systems that provided global communications and near real time observation of enemy actions, i.e., launch and pre-launch indications.

Between the end of World War II and 18 January 1991, when Iraq launched its first SCUD missile against U.S. forces, the V-1 and V-2 technology and capability did not disappear. These first generation ballistic missiles were merely reclassified as Short Range

[1] Augustine, Daniel A., "Theater Missile Defense: A Primer for the Uninitiated," (Unpublished Research Paper, U.S. Naval War College, Newport, RI: 1997, p. 2).

Ballistic Missiles (SRBMs) and relegated to a category of "lesser threat" than ICBMs. SRBMs were largely ignored by U.S. military and political leaders because the strategic threat was the USSR and the strategic weapon of choice was the ICBM.

In the same period as the Cold War, third world nations were developing their own nuclear and SRBM launch capabilities. By one recent estimate the current inventory of TBMs is 28 different missiles or missile variants held by 22 different nations (not including the U.S. or FSU).[2] Several of these same nations are also developing their own space programs, which implies the evolution of third world TBMs into ICBMs. What was once the private domain of the two world super powers will soon be a capability of many nations, some with very deeply rooted anti-American sentiments. By this same estimate, the threat from TBMs is not limited to, and most likely not to be from a nuclear warhead. The most significant threat to be faced in the Middle East and Korean theaters of operation is likely to be one of chemical or biological weapons.[3]

Since the introduction of the V-1 into modern warfare and all the technology advancements of the space age, and now the computer-enabled information age, ***how will U.S. forces, specifically the Joint Forces Commander (JFC), deal with the blossoming TBM threat?*** This paper will attempt to answer the question by examining the issue of Joint Theater Missile Defense (JTMD) interoperability at the point of its lowest common denominator – <u>data correlation and data fusion systems</u>.

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[2] Anselmo, Joseph C., "U.S. faces Growing Arsenal of Threats," AVIATION WEEK & SPACE TECHNOLOGY, Feb. 24, 1997, p. 44.

[3] Ibid., p. 46.

Chapter 2:
CURRENT DOCTRINE

Joint Pub 3-01.5, "Doctrine for Joint Theater Missile Defense," describes TMD as an "inherently joint mission." This Pub also defines the Four Operational Elements of Joint Theater Missile Defense as:[4]

- ACTIVE DEFENSE
    - ◊ Applies to Protection by: In-flight Destruction; and Destruction of Airborne Launch Platforms.
    - ◊ Includes: Multitiered Defense Indepth via Land, Sea, Air, Space and Special Operations Forces; and Active Electronic Warfare.
- PASSIVE DEFENSE
    - ◊ Applies Measures to: Reduce Vulnerability; and Minimize Damage.
    - ◊ Includes: Deception; Theater Missile Early Warning; and Nuclear, Biological and Chemical (NBC) Protection.
- ATTACK OPERATIONS
    - ◊ Applies to: Offensive action by Land, Sea, Air, Space and Special Operations Forces.
    - ◊ Includes: Destruction, Disruption or Neutralization of Theater Missile Launch Platforms; Supporting Command, Control, and Communications (C3); Logistics; and Reconnaissance, Surveillance, and Target Acquisition (RSTA) Platforms.
- TMD COMMAND, CONTROL, COMMUNCATIONS, COMPUTERS, AND INTELLIGENCE (C4I)
    - ◊ Timely and accurate data and systems to plan, monitor, direct, control and report Theater Missile Defense operations.
    - ◊ Integrated Systems of Doctrine, Organizational Structures, Facilities, Communications, Computers, Supporting Intelligence, and Missile Warning and Cueing by Sensors and Ground Stations.

[4] Joint Publication 3-01.5, DOCTRINE FOR JOINT THEATER MISSILE DEFENSE, February 22, 1996, p. I-4.

Although current doctrine speaks of "joint systems," current TMD systems and defensive strategies vary little from the approach used during World War II. The U.S. inventory of TMD systems is largely comprised of fighter/attack aircraft used in an Active Defense role and Surface-to-Air Missile (SAM) systems, as opposed to WWII anti-aircraft gun systems. The use of modern aircraft or missiles to counter the TMD threat is merely the adaptation of existing and generally Service Component unique weapons or technology to a long-standing problem. Until very recently, no TMD system was built from the ground up as a theater missile interceptor or defender. This is in large part due to the Anti Ballistic Missile (ABM) treaty signed between the U.S. and USSR in Geneva, Switzerland in 1972. New systems such as the Army's Theater High Altitude Area Defense (THAAD) missile, which is being built from the ground up as a TMD system, or modifications to existing SAM systems such the Army's Patriot or Navy's Standard Missile must be considered under the constraints of existing anti-ICBM agreements such as the 1972 ABM treaty.[5]

Given the potential for U.S. involvement in a conflict where TBMs are employed with a Nuclear, Biological or Chemical (NBC) warhead, commonly referred to as Weapons of Mass Destruction (WMD), the U.S. response will likely be the deployment of TMD assets to the target nation. This was the U.S. response to Iraq's attack on Israel and will likely be the response in the future.[6, 7] As such, the geographic Commander-in-Chief (CINC) must be prepared to provide coordinated joint and/or coalition TMD when directed by National Command Authority (NCA).[8] As of March 1997, three regional CINC staffs had fully established "TMD Coordination Cells, a hardware and software suite that allows operators to be situationally aware of TMD throughout the battlespace."[9]

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[5] Dornheim, Michael A., "Missile Defense Soon, But Will it Work?," AVIATION WEEK & SPACE TECHNOLOGY, Feb. 24, 1997, p. 39.

[6] Fulghum, David A., "Israel's Missile Defenses Rate U.S. High-Tech Boost," AVIATION WEEK & SPACE TECHNOLOGY, May 6, 1996, p. 23.

[7] "The U.S. Has Agreed," AVIATION WEEK & SPACE TECHNOLOGY, July 15, 1996, p. 16.

[8] Hildreth, Steven A., and Ellis, Jason D., "Allied Support for Theater Missile Defense," ORBIS, Winter 1996, p.102.

[9] Scott, William B., "Commanders Demand Effective Missile Defense," AVIATION WEEK & SPACE TECHNOLOGY, March 3, 1997, pp. 42-43.

Chapter 4:
SYSTEM OF SYSTEMS

Now that the concept of JTMD and Coalition TMD has been established, this begs the question, "How does the JFC/Coalition Commander address TMD interoperability across multi-service lines within U.S. forces and simultaneously develop an effective TMD Concept of Operations (CONOPS) in consonance with coalition and U.S. national security interests?" In answering this question, the thesis of this paper – data correlation and data fusion systems must be addressed, because they are at the root of the interoperability problem.

Battle Management/Command, Control, Communications (BM/C3) systems are more accurately termed a "system of systems." This refers to the fact that the total system is an integrated architecture of smaller systems such as data collection, processing, correlation, dissemination and display.

At the macroscopic level, interoperability issues within the TMD arena appear to be confined to, or largely focused on, the Active Defense roles that the services see themselves developing for the next century. More specifically, the development of new missile systems or aircraft such as the USAF Airborne Laser (ABL),[10] Army THAAD,[11] USAF Space Based Laser,[12] Navy Area-Defense (NAD),[13] and USAF AWACS Missile Launch Sensor.[14] Because TMD crosses the boundaries of so many traditional service-oriented roles and missions, the interoperability issues of TMD dive right to the heart of Battle Management – the essence of what a JFC should be doing.

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[10] http://prs.plk.af.mil/ABL/tm.factsheet.html

[11] http://vwww.clark.net/fas/MHonArc/BMDList_archive96/msg00056.html

[12] http://vwww.clark.net/fas/MHonArc/BMDList_archive96/msg00008.html

[13] Canan, James W., "The Stepping Stone to Continental Defense," SEA POWER, February 1997, pp. 35-38.

[14] Fulghum, David A., "AWACS To Carry Missile Launch Sensor," AVIATION WEEK & SPACE TECHNOLOGY, September 4, 1995, p. 42.

In an effort to better manage the multi-service interests, the Secretary of Defense established the Joint Theater Air Missile Defense Organization (JTAMDO) in January 1997. This organization is responsible for coordination with Combatant Commanders and the military services to develop joint mission capstone requirements, a joint mission architecture and a joint capabilities roadmap. Under this new management structure, Ballistic Missile Defense Organization (BMDO) becomes the integration systems architect for theater air and missile defenses. This structure focuses requirements generation and planning activities, furnishes systems-of-systems engineering at the architecture level and provides for integrated oversight by DOD senior leaders. This change is expected to significantly enhance coordination and ultimately shorten the development timelines between the requirements and acquisition communities.[15]

The JFC uses the Global Command and Control System (GCCS) as his interface to the national intelligence community and component commanders. GCCS is, among other things, the CINC's data processing, correlation and display system and is built on the concept of a Common Operating Environment (COE). Defense Information Systems Agency (DISA) is developing the Defense Information Infrastructure (DII) COE and GCCS will migrate to this standard in the near future. What the COE does for the JFC is to develop a Common Operating Picture (COP) which is critical to his understanding of the battlespace, especially in the dynamic TMD arena. This makes GCCS the preferred tool for distributed collaborative planning within the JFC staff and between Operational Commanders.

Because GCCS is the DOD's integrated C4I system, it is part of the DII and in an effort to solve part of interoperability issue among potential coalition partners and allies, the DISA is beefing up its role in foreign military sales. To date, Canada, Japan, Australia, Saudi Arabia, United Kingdom, Italy and South Korea have either purchased parts of GCCS or are investigating GCCS components for military or civil applications.[16]

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[15]WASHINGTON (AFNS), "DOD Establishes Joint Theater Missile Defense Organization," Released: January 24, 1997.

[16] Temin, Thomas R., "DII Hits International Markets," GOVERNMENT COMPUTER NEWS,January27,1997. (http://www.gcn.com/scripts/dbml.ex...FF&header=head_2&article=hilites_2).

As each service, national agency or coalition partner brings their military hardware and tactical data processing capabilities into the theater, they also bring a unique data correlation and display system into the TMD battlespace. The Navy and Marine Corps use the Joint Maritime Command Information System (JMCIS), this is the system that led directly to the development of GCCS. The Air Force is in the process of deploying and improving a system known as the Theater Battle Management/Core System (TBM/CS). The Army uses a system know as the All Source Analysis System (ASAS). All of these systems are identified as "migration systems" (the opposite of a "migration system" is a "legacy system," these system functionalities will eventually be incorporated into a migration system or deleted) which means that the services will continue to fund, develop and most importantly, progress toward compliance with GCCS COE. The goal of compliance with GCCS COE standards is not to force each service to use the same software application such as a database manager or imagery manipulation tool, but to allow each individual service component to exchange data files with apparent seamlessness across any of the GCCS applications. Another benefit of the COE architecture is that systems may be made "scaleable" simply by choosing the software modules needed for a specific service mission and integrating them with the COE.[17]

Although the concept of GCCS has been proven and fielded, it is by no means a perfect system and it is not without its own challenges. As recently as the Joint Warrior Interoperability Demonstration (JWID) 96, specific objectives were focused on GCCS:[18]

<u>Objective 4</u> was defined, "Using CENTCOM TMD concepts, demonstrate a C4I system that is tactical, quickly established, and interoperable within the GCCS COE." The technical challenges described for this JWID objective included: demonstrated system must be compatible with legacy systems (TRAP, TIBS); must demonstrate interoperability between C4 systems and TADL's (tactical data links); must operate effectively over Army/USMC tactical systems and to afloat platforms.

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[17] http://perch.nosc.mil:8095/Docs/COE/JMCIS_COE.1.html.

[18] http://www.army.mil/jwid/chal.htm

Objective 5 was defined, "Using existing CTAPS, STACCS, JMCIS, and MAGTAF C4I systems, demonstrate seamless information exchange through GCCS." The technical challenges for objective 5 included: must demonstrate database synchronization; must include vertical information exchange, especially up the chain (e.g. demonstrate automatic target nomination from within ARFOR (STACCS) into JFACC (CTAPS) with an info to both NAVFOR (JMCIS) and MARFOR (MAGTAF C4I).

One can conclude from the preceding discussion, that although GCCS and numerous other BM/C3 systems have been fielded, interoperability is still an issue of grave concern in the Joint world. One could ask then, what is the underlying cause of non-interoperability between these systems?

The root cause of the problem is the thought process within each TMD BM/C3 system. These systems work as advertised when used as standalone systems. The problem arises when they are placed in the same geographic area and forced to operate as a single system.

This then forces the JFC to ask whether he is really interested in interoperability or integration of TMD BM/C3 systems. Here are two key definitions: .[19]

in·te·grate (în'tĭ-grât') verb
inte·grat·ed, inte·grat·ing, inte·grates verb, transitive
1. To make into a whole by bringing all parts together; unify.
2. a. To join with something else; unite. b. To make part of a larger unit: integrated the new procedures into the work routine

op·er·a·ble (òp'er-e-bel, òp're-) adjective
1. Being such that use or operation is possible: an operable machine

If the JFC truly wants to be able to exercise command and control over deployed U.S. and coalition TMD systems, then what he is asking for is an integrated system, a unified system that operates as a single unit. What the JFC already has are interoperable systems and what he needs to do is optimize the use of these systems in the theater.

[19] The American Heritage® Dictionary of the English Language, Third Edition copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from InfoSoft International, Inc. All rights reserved.

Chapter 4:
SYSTEMS WITHIN SYSTEMS

The heart, or more correctly, the brain of the TMD BM/C3 system is the embedded data correlation or data fusion algorithm within the Tactical Data Processor (TDP). This is where a few definitions or naming conventions must be agreed upon:[20]

Data correlation - the association of common attributes (position, velocity, time) of a target of interest, all collected by a similar sensor type, i.e. radar, ESM, visual.

Data fusion - the association of attributes of a target of interest, collected by various sensors, not necessarily of the same type.

Algorithm - A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps.[21]

There are in general two types of data correlation schemes. These are (1) deterministic correlation and (2) probabilistic correlation. In a deterministic correlation algorithm, target observations or reports are assigned to form an object. The assignment process is "hard " in that reports that are known to come from different objects cannot be associated together in the same object. In a probabilistic correlation algorithm, the assignment process is "softer," in that more than one object may share more than one report, even though the algorithm knows that the report could not have arisen from both objects. Each of these approaches possess unique strengths and weaknesses.

Of particular significance is that probabilistic correlation allows multiple measurements to be merged or combined which provides "smoothness" to the state estimation and helps to prevent the track from being "stolen" during a track cross.[22]

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[20] Waltz, E. and Llinas, J., MULTISENSOR DATA FUSION, Artech House, Norwood, MA., 1990, p. 4.

[21] The American Heritage® Dictionary of the English Language, Third Edition copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from InfoSoft International, Inc. All rights reserved.

[22] Project Correlator Report No. 1: DATA CORRELATION - A REVIEW OF THE PROBLEM AND ITS SOLUTIONS, Calspan SRL Corporation, Working Draft, December 1995, p. 2-3.

Advances in sensor type and technology, communications, computing hardware/software (HW/SW), and long range smart weapons provide voluminous data that must be filtered and fused for the key information needed by the operational commander and his subordinates. Current operational data fusion systems are either user intensive or only automatically associate using high confidence parameters. This means that a great deal of operationally/tactically useful information is "dropped on the floor." In order to meet the accelerated tempo of the modern battlespace (especially TMD), and cost constraints, data fusion systems need to be automated. The most significant problem with current automated data fusion systems is the lack of robustness caused by the following:[23]

Conflicting data: including incorrect data in some fields (wildpoints, mis-entries, conversion errors) as well as highly uncertain data.

Partial or missing data: including default values, unknown by existing, nonexistent, no information, and uncharacterized null data.

Incompatible data types: misaligned data, different object typing conventions, data conditioned on different events, angle data from different sites, and data which could be converted to be consistent if more information were available.

Stale data: including time late, for example data having possibly valuable ID/type information, however time tagged such that correlation with current data is ambiguous or such that certain fields are outdated.

> "Specific application environments of the target tracking problem establish the fundamental requirements for the observation-to-observation, observation-to-track, or track-to-track correlation problem. Specific application factors such as target characteristics, basic mission, the observation environment, characteristics of deployed sensors, and basic mission goals and constraints strongly affect the selection of techniques for correlation. These application environment factors establish the constraints and even the degree of difficulty for correlation, ranging from a simple (or even nonexistent) problem to one which may be very difficult to solve. For some applications for example, there is no association-correlation-assignment problem because the combination of sensor accuracy and target density is such that mis-assignments are not an issue. An example of this is the situation

[23] Ibid., p. 2-11.

frequently encountered by NASA space track operations, in which a single, relatively large object is tracked in a cooperative manner (the target participates with the tracker), with well known trajectory parameters. Conversely, in many tactical data fusion applications the combination of limited sensor accuracy, dense target environment, maneuvering, non-cooperative targets with unknown a priori trajectory information etc. causes significant potential for mis-assignments."[24]

As the title of this chapter suggests, Data Correlation and Data Fusion processes occur at the very core, within the system of the TDP, whether it is called GCCS, JMCIS, or ASAS. By the very nature of an algorithm, being either math or heuristics based, the data fusion process will compete with all of the other applications (data display, numerical processing, user interface) for processing time and memory.

Figure 1, following, shows how high performance computing architecture components must be adapted to the functional components for any given problem in order to optimize operational capability:[25]

It becomes critical to understand that the automated data fusion segment in the BM/C3 system is designed to replace an "expert human analyst" and do the job faster than the human could do it. This is the fundamental basis for designing a data correlation scheme and the foundation for computer "expert systems" design and development. As such, it becomes intuitively obvious that if two machines use two different data correlation algorithms, then they are essentially operating as two different expert analysts. And it stands to reason that the data output has a greater likelihood of being different for identical data input. It also falls out that if two identical data fusion algorithms use different data input then the data output is necessarily more likely to be different. This is exactly the rub now occurring in the TMD battlespace with the proliferation of service-unique BM/C3 systems.

[24] Ibid., p. 3-1.

[25] Ibid., p. 5-4.

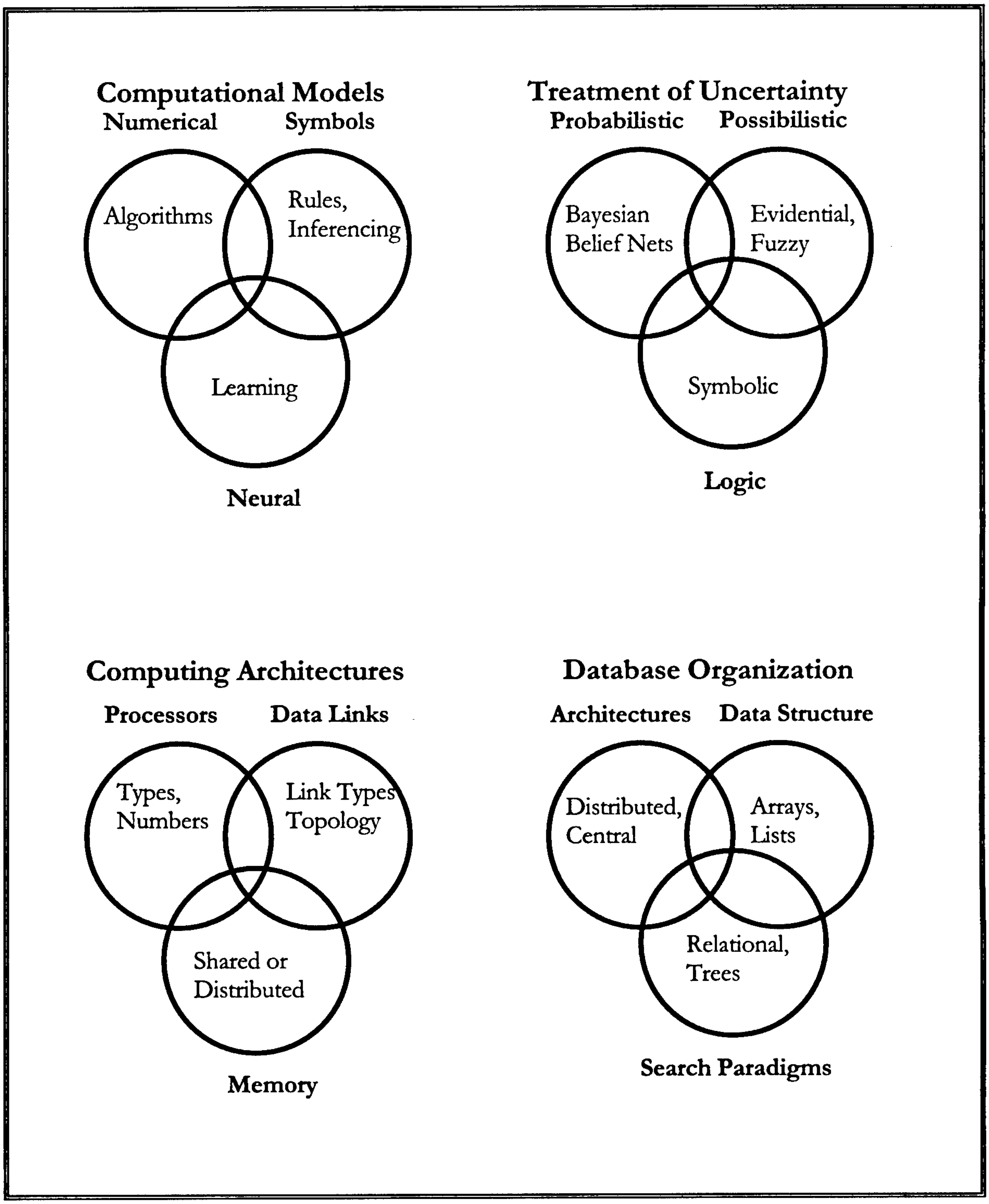

Figure 2: Computing Components versus Functional Components

Chapter 5:

CONCLUSIONS AND RECOMMENDATIONS

The JFC's perception of the TMD battlespace is a direct function of which BM/C3 system is being employed and which data links are feeding the system. The problem associated with various data correlation algorithms becomes a critical point as DII-COE becomes adopted across all service lines. A false sense of security will be realized if the JFC allows himself to believe that all players are "singing off the same sheet of music" just because he and his staff are using GCCS and all other TMD players are using GCCS compliant migration systems.

The establishment of the JTAMDO is certainly a step in the right direction to solve this problem, however, the JFC must state his requirements for the acquisition of TMD BM/C3 systems that not only present a common display of the battlespace, but systems that think the same way about the battlespace. The BM/C3 system is the JFC's interface with not only the TMD battlespace but more importantly, the entire infospace.

The problem of "mis-assignment" of state estimates to a target track is a real problem that is encountered on a daily basis. It becomes amplified in severity if the target is a TBM where track correlation and salvo size is time critical to both Active Defense and Passive Defense measures. This mis-assignment occurs principally in three areas (1) temporal attributes, (2) spatial attributes, and (3) textural attributes. These errors are an inherent function of the data collection platform and data transmission path, including all of the first order (raw data converted to intelligence) data processing. Additional errors may be introduced unnecessarily by having multiple systems simultaneously reporting a single event.

Figure 2, following, shows this problem depicted in a tactical data net. Hypothetically, a single TBM launch event may be reported near-simultaneously via TRAP, TIBS, CEC, Link-11 and Link-16. Each report must be assessed by each individual TDP to determine whether or not this is new information, amplifying information or old information. Inherent errors and transmission path errors such as rebroadcast of a Link-11 report over Link-16, where all data fields do not have a one-to-one correspondence, become additive, and a single missile salvo may be reported as many. The ramifications of such an occurrence are obvious.

Figure 3 shows how this tactical dilemma becomes compounded when the national intelligence community gets involved. Depicted in this figure are various ELINT, IMINT and SIGINT systems downloading raw or minimally processed information directly to the tactical users. An excellent example would be the Army/Navy exploitation of DSP data via the Joint Theater Air-Ground System (JTAGS). Exploitation of this information makes possible rapid detection of a missile launch event and allows for a rapid estimate of the missile launch and impact locations. When this information is received by the national collection/processing source, it is transmitted via TRAP and/or TIBS and introduced into the theater TDPs a second time.

Combining Figures 2 and 3, one sees that information could be received via a national source directly into theater, received again when the national source transmits their processed information (read time-late) and again by in-theater organic sensors such as Aegis radars linked via CEC. All of these reports are able to be broadcast to tactical users in a variety of ways as shown in figure 2.

Figure 4 shows how the Joint Forces Air Component Commander/Area Air Defense Coordinator (JFACC/AADC) might consolidate all tactical information in-theater and broadcast the definitive tactical battlespace picture to all users. A system capable of doing such a broadcast is the Global Broadcast System (GBS), which takes its roots from the commercial Direct Broadcast Satellite (DBS) technology. The JFACC would also be capable of broadcasting tactical/situational updates to higher authority via the same system. The JFACC-GBS broadcast system would in essence level the playing field for all TMD assets by providing the proverbial "single sheet of music" to sing from.

Figure 5 takes this concept one step further and shows the CINC updating the Operational picture of the battlespace for the Service Component Commanders and NCA. This would be the level where NCA directions become Operational Plans based on the very best information available. At the Operational level, the JFC would be responsible for

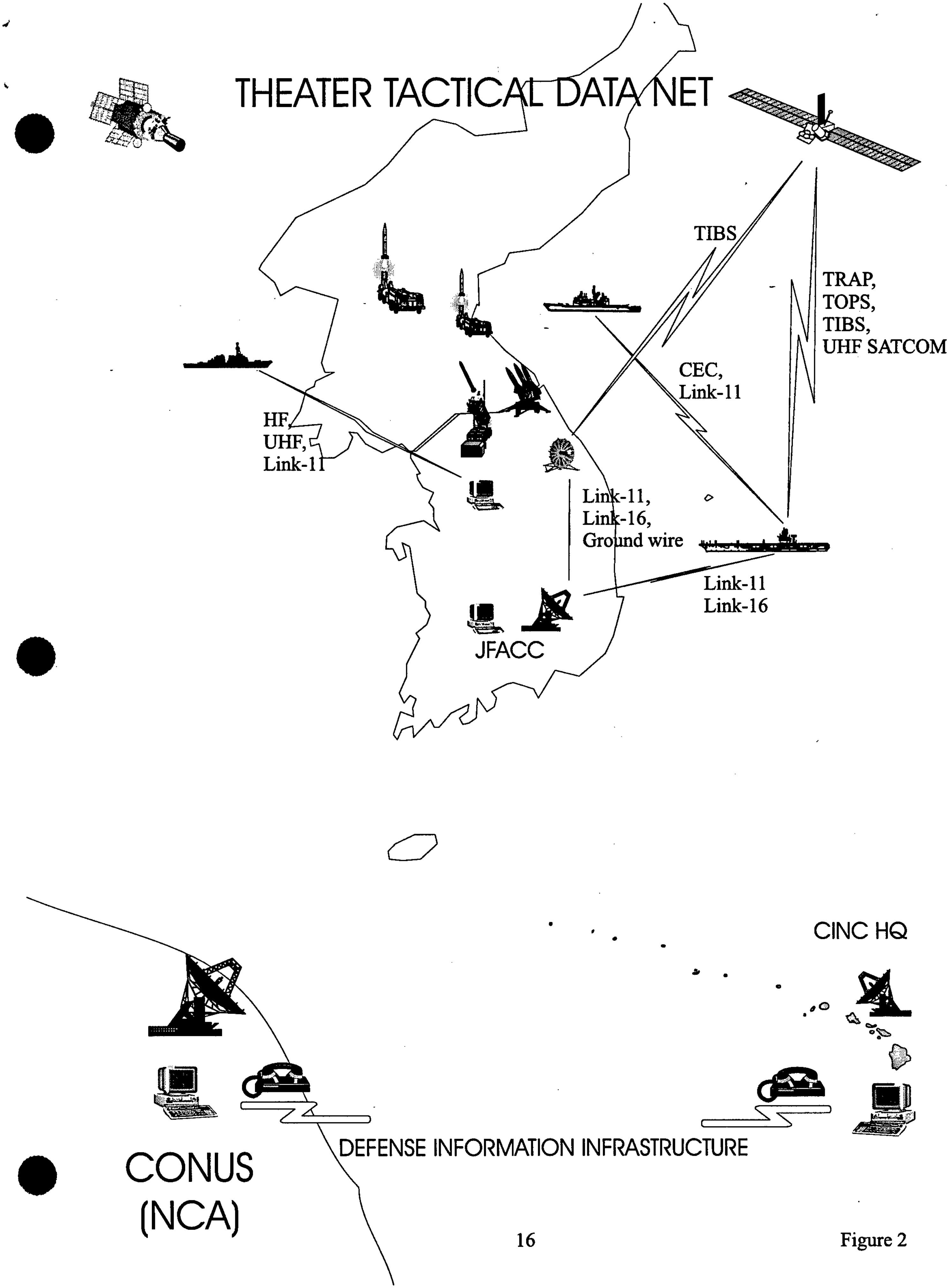
THEATER TACTICAL DATA NET
TIBS
TRAP,
TOPS,
TIBS,
UHF SATCOM
CEC,
Link-11
HF,
UHF,
Link-11
Link-11,
Link-16,
Ground wire
Link-11
Link-16
JFACC
CINC HQ
CONUS
(NCA)
DEFENSE INFORMATION INFRASTRUCTURE

Figure 2

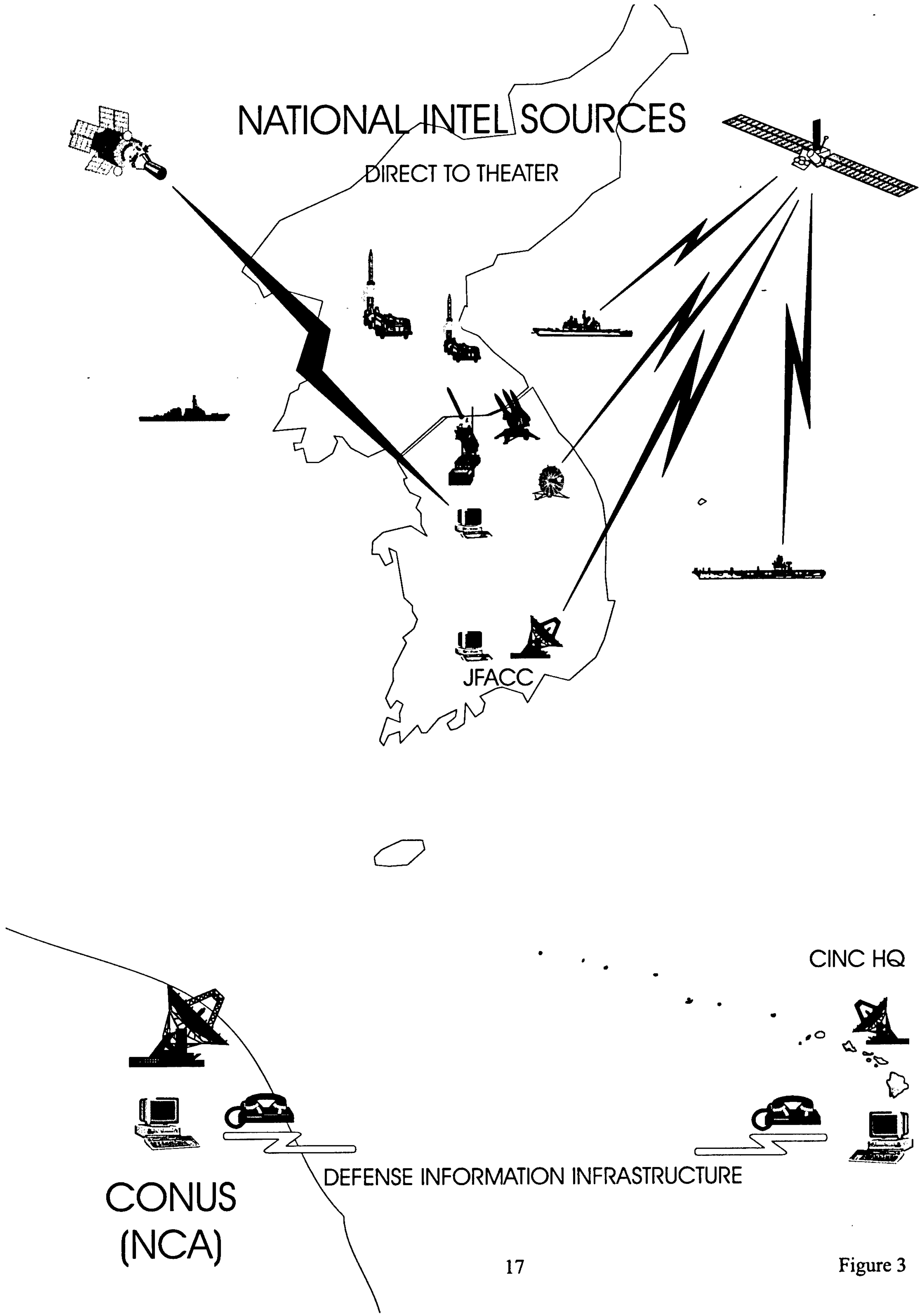
NATIONAL INTEL SOURCES
DIRECT TO THEATER
JFACC
CINC HQ
DEFENSE INFORMATION INFRASTRUCTURE
CONUS
(NCA)

Figure 3

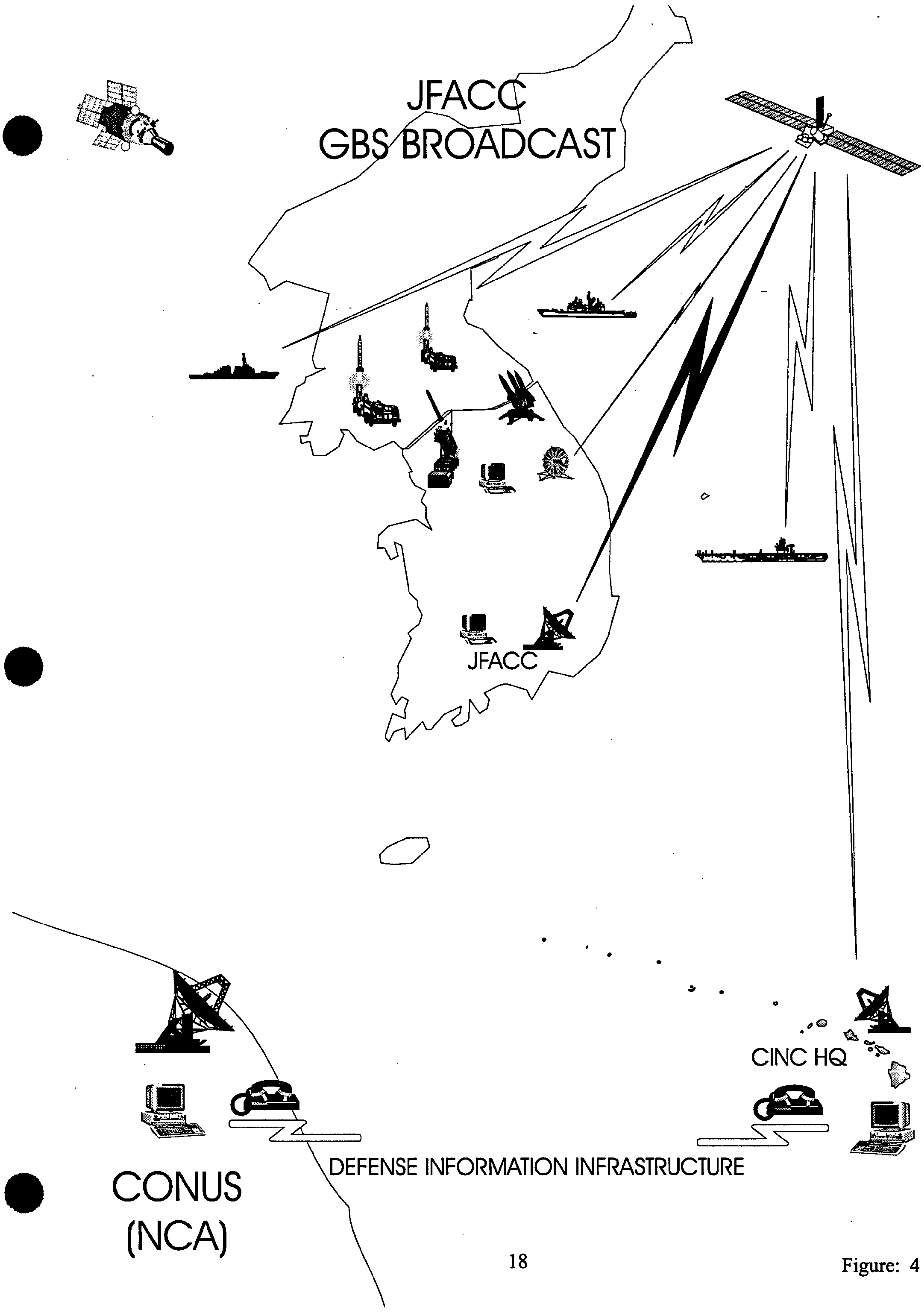
JFACC
GBS BROADCAST
JFACC
CINC HQ
DEFENSE INFORMATION INFRASTRUCTURE
CONUS
(NCA)

Figure: 4

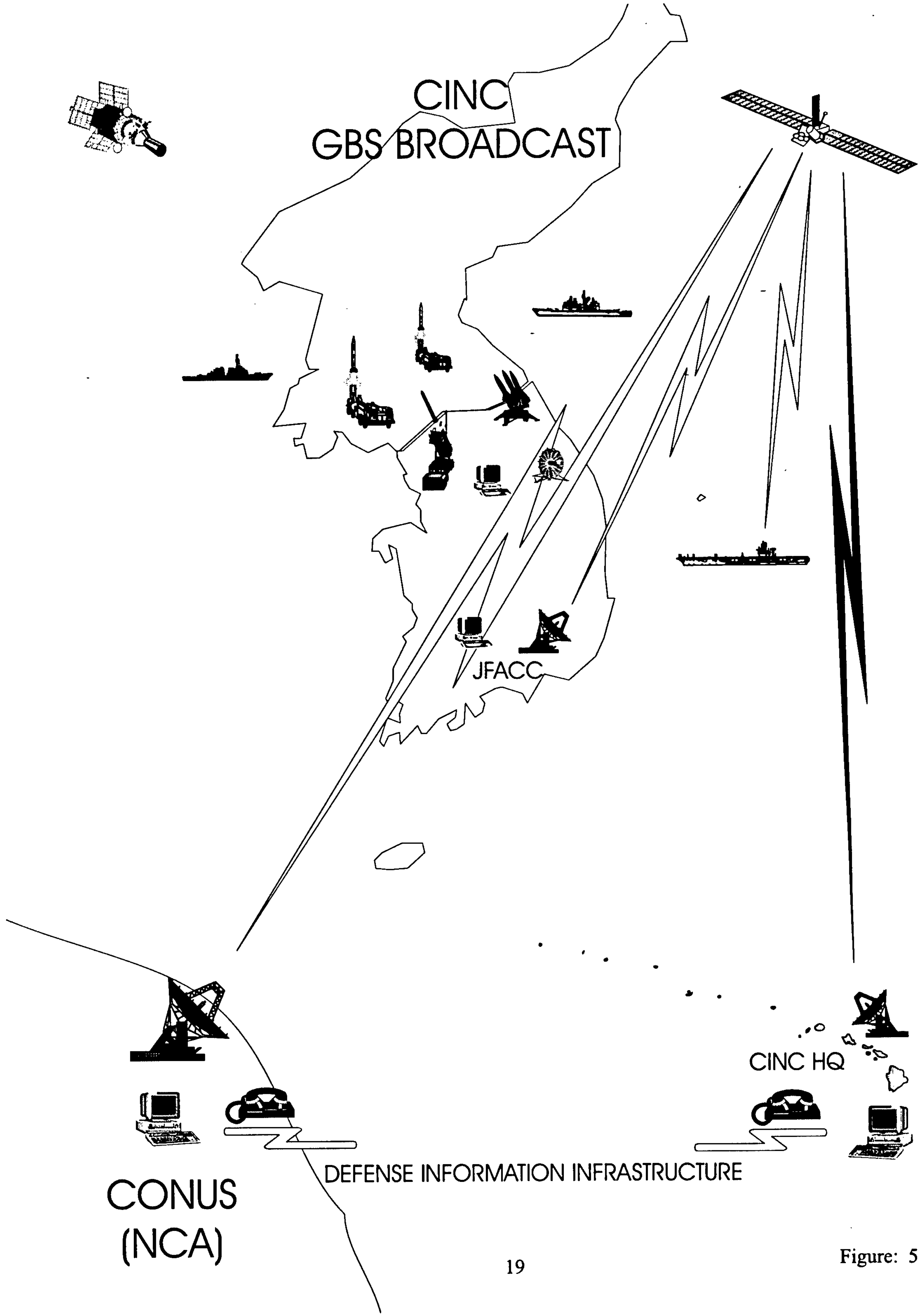
CINC
GBS BROADCAST
JFACC
CINC HQ
DEFENSE INFORMATION INFRASTRUCTURE
CONUS
(NCA)

Figure: 5

injecting Superior Commander's intentions, national source intelligence regarding enemy intentions and geo-political assessments. This information would be broadcast to the subordinate commanders and GCCS could operate efficiently as a distributed collaborative planning tool as well as provide a seamless overlay of the Operational picture on top of the tactical picture.

In summary, the bottom line conclusion is that the existing BM/C3 systems may be optimized for use in the TMD arena by constructing the appropriate information architecture for TMD. This architecture would eliminate as many sources of data correlation error, as defined in chapter 4, as possible. By changing the information flow, it is possible to optimize use of both national and theater TMD assets. The JFC must be aware of the problem of adding new assets that do not provide new capabilities and only serve to muddy the waters around him.

Final recommendations to the Operational Commander include:

- Establish a billet of Joint Forces Over-the-horizon Track Coordinator (J-FOTC)
  - ◊ Develop Functionalities of the Battlespace Manager:
    - i) Define track reporting responsibilities for all TMD players in consonance with their TMD engagement or surveillance capabilities.
    - ii) Define the Information Order of Battle:
      - a) First reports via which links and from which sensors?
      - b) Initial TBM launch and impact location predictions processed from which theater or national systems?
      - c) Amplifying information from which sensors in a prioritized listing?
      - d) Define criteria for when to drop initial launch/impact predictions and adopt updated information based on track history from theater organic sensors (transition from first-order calculations to second-order).
    - iii) Deconflict reports and eliminate unnecessary information.
    - iv) Establish the fusion point for all nationally derived intelligence and Theater Situational Awareness.
  - ◊ Pre-define the TMD information architecture for the specific theater of operations based on coalition and U.S. assets assigned.

- Advocate TMD BM/C3 systems that are based on common thought processes:
  - ◊ Advocate the identification of a family of data correlation and data fusion systems that may be integrated into existing or new BM/C3 systems.
  - ◊ Advocate the Joint acquisition of a TMD BM/C3 system for the 21st century.
  - ◊ Advocate the incorporation of CEC capability into GCCS.
  - ◊ Advocate the incorporation of near real time, nationally derived information into systems such as CEC.

The long-term goal must certainly be to develop a joint BM/C3 system that satisfies TMD and all other Battle Management requirements. In the interim, however, there are solutions and the JFC must exercise the available assets in a variety of information architectures to determine optimal data flow and determine which architecture yields the highest fidelity information.

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